Personal Health Maintenance

The Cost-Effectiveness of Health Checkups— An Illustrative Study

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An economic analysis of personal health maintenance is complicated by the great variability in the health care process, the large amount of missing data and the great range in analytic results. Accordingly, this study should be considered more illustrative than conclusive. Data are available on middle-aged adults that periodic health checkups can be effective in significantly lowering mortality from potentially postponable disease. Using these data, a net-cost analysis has been attempted for periodic health checkups. The findings suggest that their costs and effects on health depend on how they are provided, how often and to whom. Yet, periodic health checkups can reduce lost earnings capability of examinees and can be cost-effective by using efficient health examination methods. If policy decision makers require health checkups for the lowest income people to be cost-effective, then these checkups probably will continue to be limited to case finding by physicians as an expense already included in current medical practice.

Personal health maintenance, for the purposes of this economic analysis, is considered to include two groups of professional health care services—namely, health promotion and health status evaluation.

Health promotion involves health education and counseling to encourage persons to better their health through an improved life-style. Traditionally, primary care physicians include some health education and counseling in their routine patient care. Formal organized health promotion programs often include counseling for stress, smoking cessation, nutrition or weight reduction and improved physical fitness. These are usually carried out by nonphysician health care providers.

Health status evaluations (also called general physical examinations, health checkups, multiphasic checkups, health appraisals or case findings) are used to monitor a person's health, to identify high risks for specific diseases and to detect early abnormalities. Groups at high risk are those in whom the frequency of disease is demonstrably higher than in the general population. Disease is detected through health checkups or case finding. A health checkup is a group of procedures and tests provided to a presumably well person and generally includes a medical history, a general physical examination and supplemental laboratory or radiology procedures (or both), selected to determine the risk of future disease or to identify common important diseases still in their asymptomatic state. Health checkups are usually provided by physi-

cians or by trained nurse practitioners or physician assistants working under physician supervision. Systemized approaches, such as multiphasic health checkups, sometimes involve automated procedures and technicians to collect data on patients' histories, laboratory tests and physiologic measurements in a programmed sequence.[1-3] Case finding includes supplemental health checkup test procedures during the medical examination or diagnostic workup of patients having one or more specific medical complaints or problems. Thus, case finding involves waiting for sick people to seek medical care and then providing additional testing procedures for the detection of selected potentially postponable conditions. Periodic health checkups usually are the primary basis for personal health maintenance programs; they consist of health protection plans that include test packages appropriate for different age groups.[4-7]

A test is considered appropriate if it has a high predictive value when positive—it has a high sensitivity for identifying a possibly disabling disease occurring with a relatively high prevalence, and a high specificity for identifying persons without the disease—and if there is available an efficacious treatment for the disease.[8]

The effectiveness of a health program is generally expressed as the extent to which its intended objectives are actually achieved. The effectiveness of periodic health checkups can be assessed by such patient outcome measures

as morbidity, disability and mortality. The most reliable method for measuring effectiveness is by a randomized controlled study.[9]

Costs for personal health maintenance services are usually established by individual health care providers who receive fees from patients as payments for these services, since personal health maintenance services are rarely covered by medical insurance programs.

Accordingly, health checkups may be included in case finding, whereby their costs then become reimbursable by third-party health insurers as services associated with a patient's medical complaints. Thus it is probable that many persons are already receiving such personal health maintenance services and their costs are already contained (but not identifiable) in the overall medical care costs. Health maintenance organizations provide many of these services on a prepaid basis and, when health checkups are included as a covered benefit, these costs can then be separately identified.

Many economists regard preventive medical services as an investment in health because they expect such services to increase the health of persons and reduce the future cost of medical care for some illnesses.[10]

Methods

An economic analysis of personal health maintenance services requires determining their costs. These costs will depend on the specific process used for providing these services—that is, whether a physician or a nonphysician health care provider, in solo or group practice—and the financing mechanism for paying for these services—that is, fee-for-service, cost reimbursement or prepaid insurance. It is often very difficult to establish true costs because charges (fees) of physicians and hospitals do not necessarily reflect actual costs.[11] Total costs should contain both direct and indirect costs. Direct costs include payments to hospitals and physicians; indirect costs include overhead expenses. For patients' costs, not only payments for services should be considered, but also patients' loss of earnings from being absent from work.[12-19]

In projecting future costs and benefits, estimates must be made for the effects of economic inflation by adjusting for a projected inflation rate. For long-term cost projections, low inflation rates tend to favor programs such as personal health maintenance whose major benefits tend to accrue in the distant future.[20-22]

The comparative effectiveness of alternative medical procedures can be best evaluated through randomized controlled studies; the data from such studies then permit a cost-effectiveness or a cost-benefit analysis.[17,19,20]

A cost-effectiveness analysis is a comparison of the costs and effects from alternative methods directed to achieving the same objective, for example, comparing the dollar expenditures and the effects on health of persons receiving a formal program of personal health maintenance with persons not receiving such a program. In a cost-benefit analysis, all the expenditures of alternative programs are compared with all the benefits derived. This requires reducing the value of all benefits to similar monetary terms (such as dollars) including, for example, the value of extended years of life. The value of a year of life is often defined as the average earnings of a person during a year.[13,14] Quantifiable measures of all relevant inputs

and outputs to health care programs are not obtainable, so that incremental changes in health status resulting from additional services received are generally the most useful form of economic analysis. In such a study of personal health maintenance services, the additional costs of providing these specific services should be considered, as well as the resultant effects of these services on patients' outcomes.

Because all the definitive data required to carry out a cost-effectiveness analysis are usually not available, a series of assumptions must be made for the important variables and then various scenarios projected that provide a "sensitivity" analysis. Thus, one can test how sensitive are the analytic results to possibly important variations in the data used, and thereby attempt to decrease the range of uncertainty in policy-making decisions.[21]

Because health education and counseling are usually an integral part of traditional patient care by health care providers, it is difficult to estimate accurately the separate costs for these two services. The patients' outcomes from such health promotion components are usually expressed in terms of measured behavioral and life-style changes. Thus, measuring costs and benefits for health education programs is very difficult,[10,23] and an economic analysis of the health promotion component of a personal health maintenance program will not be attempted herein. Also, I will not attempt to evaluate the issues of patient compliance with recommended follow-up procedures, the value of reassurance to an anxious patient that a suspected disorder is not present and social costs such as the adverse effects of "labeling" persons found to have abnormalities.[24]

From the viewpoint of a health care policymaker, the cost-effectiveness of periodic health checkups, which generally serve as the basis for personal health care services, depends on the age of the examinees (older persons have different and more abnormalities than the young); the selection of low-cost tests with a high sensitivity for detecting abnormalities and high specificity for identifying persons who do not have the abnormality; the selection of potentially disabling abnormalities with enough prevalence to provide an acceptable cost per true-positive case; the availability of treatment to effectively decrease morbidity, disability and mortality; the intervals between repeat health checkups, and the earning capacities of the examinees.[7]

A useful economic analysis for a preventive program is the net cost, calculated as the costs of the program of examinations plus follow-up medical care, minus the reduction in medical care expense due to a decrease in disease incidence or severity, or both, and the increased income due to lengthened life expectancy and reduced work absenteeism. In such studies disease detection programs for hypertension[16] and for colon cancer[16,25] have reportedly been very cost-effective. In some industries, providing periodic health examinations to company employees has been cost-effective and resulted in substantial net earnings to the company.[26,27] Similar favorable findings were reported for life insurance policyholders.[28]

A Net Cost Analysis

A cost analysis of two alternative health checkup methods was done in which similarly selected patients receiving either a traditional or a multiphasic health checkup were compared.[29] A multiphasic health checkup consisted of a system-

TABLE 1.—*Summary of Total Costs per Patient for a Health Evaluation (Initial and Follow-up Procedures) Adjusted for Age, Sex and Health Status* [*][†]

	Traditional	Multiphasic
Physician visits	$ 79	$44
Multiphasic laboratory	0	35
Clinical laboratory	32	5
X-ray studies and other	13	5
Total	$124	$89

[*]Modified from Collen et al.[29]
[†]Adjusted to 1984 dollars.

ized battery of tests and a self-administered medical history, followed by a 15-minute scheduled visit for a physical examination by a physician in the medical department. A "traditional" health checkup was provided by one of the same medical department physicians who, during a 30-minute scheduled visit, took a history, did a physical examination and arranged for supplemental diagnostic tests and procedures as indicated. After the physician saw a patient, in either a traditional or a multiphasic initial examination visit, the physician could refer the patient to appropriate follow-up specialty clinics or for clinical laboratory tests, x-ray films, electrocardiograms or other special procedures as necessary to confirm the presence or absence of a suspected condition. The resultant patient group data were adjusted so as to be comparable by age, sex and health status. Because the same physicians provided all the examinations and the follow-up care for both groups, the quality of professional care was assumed to be similar.

From this study,[29] the total costs (adjusted to 1984 dollars) for providing health checkups by the two methods were compared (Table 1). These costs are calculated to be the actual expenses to the Kaiser-Permanente medical care program, a prepaid group practice health maintenance organization, and do not represent fees or charges to patients. The total cost for a health checkup is the sum of the resources used in the initial examination visit and in the follow-up visits required to complete the health status evaluation of a patient. The data show that the average cost for a health evaluation by a traditional physician examination and follow-up in 1984 would be $124. As an alternative, by first providing multiphasic health testing followed by a physician examination, the total costs for a health evaluation in 1984 would be $89, or a decrease of 28%.

Many studies have been done evaluating the effectiveness of individual tests and procedures for detecting specific diseases, but the results of only one long-term, randomized controlled study of periodic health checkups have been published.[24,30] A group of more than 5,000 adults (aged 35 to 54 years at entry to the study) were urged to have a multiphasic health checkup annually, a comparable control group was not so urged and both groups received their follow-up care from the Kaiser-Permanente medical care program. After 11 years, about 70% of both the study and the control groups remained in the program. A study of mortality rates showed that, compared with the control group, after seven years the study group had had a 50% reduction ($P < .025$),[31] after nine years a 36% reduction ($P < .05$)[24] and after 11 years the study group still showed a 35% reduction ($P < .05$)[32] in deaths from prespecified "potentially postponable" conditions, largely due to lower death rates from colorectal cancer and hypertension

(Table 2). Because all persons eventually die, it can be expected that the differences in mortality between these two groups will steadily decrease in time. It was not expected that other causes of death that were not preventable or postponable would be affected by these checkups.

Because it is uncertain to what extent these data for costs and patient outcomes are transferable to another environment and projectable into the future, it is useful to decide on a likely range for these important variables to attempt to decrease the uncertainty of decision makers and reduce the risk of a bad decision. Accordingly, a sensitivity analysis has been done using what are considered to be realistic values for the next ten years. Ranges are then defined as to what might be optimistically the best case and pessimistically the worst case. Three "optimistic," "realistic" and "pessimistic" scenarios can then be developed.

Assume that 1,000 adults, ages 35 to 54 years, follow the Kaiser-Permanente experience.[24,30-35] Assume optimistically that they would follow the study group model and receive, on the average, five checkups in ten years (that is, one in 1984, 1986, 1988, 1990 and 1992), that realistically they would follow the control group's experience and average two checkups in ten years (for instance, one in 1987 and a second in 1990) and that pessimistically they would take only one checkup in the next ten years (that is, only in 1988). Table 3 shows the data for the group with one checkup in ten years extrapolated from the other two groups.

Based on the Kaiser-Permanente randomized controlled study, it can be projected that the number of deaths at the end of ten years from colorectal cancer will be 1.0 for the optimistic group—that is, with five checkups in ten years—and 3.3 for the realistic group—that is, with two checkups in ten years. We then extrapolate 5.0 deaths for the pessimistic group. Similarly, it can be projected that the number of deaths from hypertensive disease at the end of ten years will be 2.5, 4.7 and 8.0, respectively, for these three groups.

The following (1984) dollar costs are then assumed (also based on Kaiser-Permanente data), as shown in Table 3. The average cost for a complete health checkup is assumed to be optimistically (by a systemized multiphasic checkup) $90, realistically (by the traditional physician checkup or case finding) $125 and pessimistically $250. Of course, the range of costs for checkups, as well as for the other medical costs that follow, may be much greater than these averages.

For the purposes of this analysis, it is assumed that the only significant differences in mortality due to periodic health checkups were in two potentially postponable conditions, colorectal cancer and hypertension, and all medical care calculations are based on these two differences. From a review of the Kaiser-Permanente medical records of terminal cases in the reported controlled study, the average total medical costs for a case of colorectal cancer are estimated to be about $12,000, resulting from about 20 physician office visits, 25 hospital days, major abdominal surgical procedures, multiple endoscopy and x-ray procedures and many clinical laboratory tests. Accordingly, a realistic cost for a terminal case of colorectal cancer is considered to be $12,000, an optimistic figure is assumed to be $8,000 and a pessimistic cost is assumed to be $20,000. For a case of colorectal cancer detected early by checkup in which the patient does not die, the medical care costs are estimated to be about a fourth that of a terminal case.

For hypertensive patients who died of congestive heart failure, myocardial infarction, stroke or renal failure, the review of actual case records showed a great variance in the course of the disease. Some patients died suddenly of a massive cerebral hemorrhage and incurred minimal medical care costs, whereas others received many years of medical care including many admissions to hospital for congestive heart failure and accrued very large medical care costs. It is assumed, for this economic analysis, that optimistic, realistic and pessimistic medical costs for the care of terminal hypertensive disease averages $6,000, $10,000 and $18,000, respectively. The medical care costs for the treatment of cases of hypertension detected earlier and in which the patients did not die were essentially only from extra office visits for a relatively small number of patients; they would not affect the costs significantly and were not included.

The earnings capability of a person, when such is lost due to illness, is an important cost to a patient and essential to consider in projecting long-term costs for a health program.[20] Earnings capability for a housewife are often imputed by courts at some contemporary value.[13] Accordingly, Table 3 assumes a realistic average earnings capability for all middle-aged persons in 1984 at $25,000, optimistically at $50,000 and pessimistically at $10,000.

Projecting future economic inflation rates is hazardous and the long-term cost-effectiveness of a procedure or program is very sensitive to the rate of inflation. For this economic analysis, the same inflation rates are applied to both projected costs and earnings. An average annual inflation rate over the next ten years is assumed to be realistic at 6%, optimistic at 3% and pessimistic at 10%.

Using all of the values shown in Table 3, the appendix of this article shows the calculations associated with the genera-

tion of various scenarios and their projected ten-year costs (see Table 4).

Discussion

This economic analysis shows how complex it is to attempt to use formal cost-effectiveness studies for health care due to the unavailability and uncertainty of analytic data, which can produce a great range of results. Also in this study the issues of patient compliance with recommended follow-up procedures, the value of reassurance to an anxious patient that a suspected abnormality is actually not present and social costs such as the adverse effects of labeling persons found to have abnormalities were not considered.[24] There are alternative methods with different costs for providing health checkups; the costs and outcomes are very sensitive to the interval between checkups. The scenarios in Table 4 show that at the same realistic unit costs, changing from five checkups in ten years (scenario V) to two checkups in ten years (scenario IV), or to only one checkup in ten years (scenario III) considerably reduces the total costs expended for checkups (from $775,000 to $315,000 to $153,000 over ten years). However, the costs for care of patients with colorectal cancer or hypertensive disease are substantially increased (from $54,000 to $113,000 to $177,000) with the associated increased loss of total earnings capability (from $550,000 to $1.26 million to $2.05 million). If a scenario were generated for those never receiving any checkups at all in ten years, these differences could be even greater.

Because scenarios III, IV and V are similar in that they all use the same realistic unit costs and inflation rate, the effects of receiving health checkups only once, twice or five times in ten years can be compared by calculating annual net cost per life saved. Scenario V with five checkups in ten years versus

TABLE 2.—Death Rates per 1,000 in Study and Control Groups, After 7, 9 and 11 Years*

	After 7 Years†		After 9 Years‡		After 11 Years§	
	Study	Control	Study	Control	Study	Control
Potentially postponable causes	3.7	7.4‖	6.8	10.7¶	8.6	13.2
Cancer of colon and rectum	0.4	1.8¶	0.6	2.5¶	1.0	3.3
Hypertension and hypertensive cardiovascular disease	0.6	2.2¶	2.0	4.0	2.5	4.7
All causes	35.6	39.2	53.7	55.1	68.7	71.0
Average number of examinations	3.5	1.3	4.5	1.7	5.2	2.0

*Populations as of January 1, 1965; study, N=5,138; control, N=5,536.
†Modified from Dales et al.[31]
‡Modified from Friedman.[24]
§Modified from Dales et al.[32]
‖P<.025.
¶P<.05 (χ^2 test).

TABLE 3.—Assumptions of Possible Variations in Important Variables

	Projected Scenario		
Variable	Optimistic	Realistic	Pessimistic
Checkups in 10 years	5	2	1
Average deaths per 1,000 after 10 years from			
Colorectal cancer	1.0	3.3	5.0
Hypertensive disease	2.5	4.7	8.0
All potentially postponable conditions	8.6	13.2	18.0
All causes	68.7	71.0	73.0
Average cost (1984 $) per			
Health checkup	90	125	250
Terminal colorectal cancer case	8,000	12,000	20,000
Terminal hypertensive disease case	6,000	10,000	18,000
Average annual earnings capability (1984 $)	50,000	25,000	10,000
Average annual inflation rate (%)	3	6	10

TABLE 4.—Projected 10-Year Costs ($) for 1,000 Adults Under Various Scenarios

| | Scenario Variables | | | | | | |
	Checkups in 10 yrs	Patient Outcome	Projected Costs	Total Checkup Costs	Medical Care Costs*	Total Program Costs	Lost Earnings Capability*
I.	1	Pessimistic	Pessimistic	$355,386	$357,242	$712,628	$ 951,665
II.	5	Optimistic	Optimistic	493,482	33,386	526,868	984,813
III.	1	Pessimistic	Realistic	153,234	176,750	329,984	2,051,530
IV.	2	Realistic	Realistic	315,449	113,119	428,568	1,262,480
V.	5	Optimistic	Realistic	775,365	54,713	830,078	552,335

*For cases of colorectal cancer and hypertensive disease.

scenario IV with two checkups in ten years results in a saving over ten years of 4.5 lives from potentially postponable conditions—colorectal cancer and hypertensive disease—at an increased cost of $459,916 for health checkups but at a saving of $58,406 in medical care costs for these cases. Total medical program costs (for checkups and medical care) are shown in Table 4 for scenario V as $830,078, or $401,510 greater than for scenario IV. However, scenario V shows a reduction in lost earnings compared with scenario IV of $710,145, for a net ten-year overall net saving of about $300,000 to the community for the medical care program and the patients, in addition to the 4.5 more lives saved.

Scenario III, with only one health checkup in ten years, saves $622,131 over ten years for health checkups compared with scenario V, but spends $122,037 more in ten years in medical care costs for colorectal cancer and hypertension cases. Total medical program costs for scenario III are only $329,984. However, checkups only once in ten years, compared with checkups every other year, lose for these patients $1,499,195 in earnings capabilities over ten years. Accordingly, scenario V net cost compared with scenario III for ten years is almost $1 million less and saves 9.5 more lives.

Assuming scenario V were modified to use a systemized multiphasic type checkup at a $90 unit cost in 1984, then total ten-year costs for checkups every other year would be similar to that for scenario II and medical care costs and lost earnings would be similar to that of scenario V. Thus ten-year total program costs would be about equal to the ten-year lost earnings capability. Although ten-year total program costs for modified scenario V with multiphasic checkups would remain about $200,000 greater than for scenario III, ten-year total lost earnings would remain $1,499,195 less. This would result in a ten-year overall net saving of about $1.25 million and 9.5 more lives saved.

For persons with average annual earnings of less than $10,000, it is only possible to balance the overall net costs by decreasing the costs for health checkups. Thus, it is evident that periodic health checkups can be a cost-effective basis for personal health maintenance depending on who receives them and how the tests are selected and furnished. They easily can be made cost-effective by selecting high-income examinee groups and providing systemized multiphasic type checkups, which include low-cost test procedures for high-risk potentially postponable conditions. Does that mean that saving the lives of persons from very low-income groups is not as beneficial? Decisions on such issues by health care policy makers are often made on a sociopolitical basis.[20-22]

Because an economic type of analysis is most useful for cost-containment decisions, it is limited in its ability to help with health care policy decisions, as valid quantitative measures of effects and benefits on quality of care are not available and the validity of estimating any such variables used is controversial. Similarly, social values, ethical considerations and political realities may well take precedence over analytic economic results. The Congressional Office of Technology Assessment (OTA) has noted that the conflict between equity and efficiency is an important issue in the use of economic analysis; it cites the difficulty in measuring a person's worth, assigning value to equality, fairness and justice and of valuing the quality of extended years of life.[20] OTA has also pointed out that economic analysis has had little relevance to decision making in medical practice because its primary focus is cost-effectiveness from a societal or policy-making viewpoint. In addition, because a physician's major responsibility is to patients, the perspective of a physician may be different from that of a policy maker or of a patient. From the viewpoint of a patient, does one seek a health checkup because one thinks it is cost-effective, because one wants reassurance and peace of mind or because it is required for some reason? It is unlikely that most persons buy a health checkup with the purpose of gaining quantifiable benefits.

Even though the cost-effectiveness of health checkups may not be demonstrable to everyone's satisfaction, a significant percentage of Americans is already for various reasons receiving health evaluations, medical checkups, case finding, employment examinations and physical fitness appraisals. Many are following the model set by government officials, generals and industry executives for periodic health evaluations. It is not possible to isolate expenditures for personal health maintenance services in the course of physician office visits, but these expenses are already built into our nation's overall health care costs. If medicare and health care insurers all paid for periodic health checkups, then the costs for these personal health maintenance services could be better identified.

Appendix

I. A Pessimistic Scenario

Using the assumed "pessimistic values" shown in Table 3, the projected cumulative costs for ten years for 1,000 middle-aged adults can then be estimated as follows:
1. The cost per checkup at a 10% average annual inflation rate in 1984 is $250 and in 1988 would be $366.
2. The number of examinees (assuming 7.3 deaths per year from all causes and all survivors have one checkup) in 1984 is 1,000 and in 1988 would be 971.
3. The average costs for checkups in a ten-year period are $366 × 971 = $355,386.

4. The costs for terminal cases of colorectal cancer and hypertensive disease: Assuming average costs of care for colorectal cancer in 1984 are $20,000, at an average rate of 10% inflation, the average cost for colorectal cancer for the ten-year period is $29,282. For five terminal cases of colorectal cancer in the ten years, the ten-year costs of care are $146,410. Assuming the average costs of cases of hypertensive disease in 1984 are $18,000, at an average annual inflation rate of 10%, the average cost for a hypertensive case in the ten-year period would be $26,354. Then for 8.0 cases of terminal hypertensive disease in ten years, the total ten-year costs would be $210,832. The total ten-year costs for both colorectal cancer and hypertensive disease would be $357,242.

5. Assuming a pessimistic average earnings capability in 1984 to be $10,000, at a 10% average annual inflation rate, the average earnings in 1988 would be $14,641. Again, assuming all terminal cases to be evenly distributed, the average cumulative projected earnings of each would be $14,641 × five years = $73,205. For 13 cases, the cumulative projected earnings lost due to deaths from colorectal cancer and hypertensive diseases would total $951,665.

II. An Optimistic Scenario

Using the assumed "optimistic" values shown in Table 3, the projected cumulative costs for ten years for 1,000 middle-aged adults would then be as follows:

1. Cost per health checkup, at 3% annual inflation rate, in 1984 would be $90.00; in 1986, $95.48; in 1988, $101.29; in 1990, $107.46, and in 1992, $114.00.

2. The differences in death rates from all causes shown for optimistic and pessimistic scenarios in Table 3 are slightly less than the differences for deaths from possibly postponable causes. The use of either will not significantly affect this net cost analysis. Accordingly, the number of examinees, assuming 6.87 deaths per year from all causes as shown in Table 3 and that all survivors have checkups, will be 1,000 in 1984; 986 in 1986; 973 in 1988; 959 in 1990, and 945 in 1992.

3. Annual costs for health checkups:

1984	=	$ 90.00	×	1,000	=	$ 90,000
1986	=	95.48	×	986	=	94,143
1988	=	101.29	×	973	=	98,555
1990	=	107.46	×	959	=	103,054
1992	=	114.00	×	945	=	107,730
Total ten-year checkup costs					=	$493,482

4. Total costs for care of cases of colorectal cancer and hypertensive disease—assuming the average cost for care of a patient with terminal colorectal cancer in 1984 is $8,000, at 3% annual inflation rate—in 1988 will be $9,004 for one case. Compared with scenario I, the care for four colorectal cases in which disease was detected early and the patients did not die will be $8,000. The average cost for care of hypertensive disease in 1984 is $6,000; at a 3% annual inflation rate, in 1988 it will be $6,753; for 2.5 cases, $16,882. The total ten-year costs for care of cases of colorectal cancer and hypertensive disease would be $33,886.

5. Assuming the average optimistic annual earnings capa-

bility for survivors in 1984 is $50,000, at a 3% average annual inflation rate, in 1988 it would be $56,275. Assuming the terminal cases were evenly distributed during the ten-year period, the average patient would earn $56,275 a year × five years = $281,375. For 3.5 cases, the cumulative projected earnings lost due to deaths from colorectal cancer and hypertensive disease would total $984,813.

III. A Pessimistic-Realistic Scenario

In scenario III of Table 4, ten-year costs are projected for a similar group receiving only one health checkup in ten years, with the associated pessimistic patient outcomes shown in Table 3, yet holding all unit costs at realistic values and a 6% inflation rate. The calculated total ten-year costs for health checkups would be only $153,234, but the total medical care cost for cases of colorectal cancer and hypertensive disease would be $176,750 and their cumulative lost earnings would total $2,051,530.

IV. A Realistic Scenario

Following the same method and using the "realistic" values shown in Table 3, the projected cumulative costs for ten years for 1,000 middle-aged adults would then be as follows:

1. The cost per checkup at a 6% average annual inflation rate would be in 1984, 1987 and 1990, respectively, $125.00, $148.88 and $177.32.

2. The number of examinees (assuming 7.1 deaths per year from all causes and that all survivors have checkups) would be in 1984, 1987 and 1990, respectively, 1,000, 979 and 957.

3. The costs for health checkups in 1987 and 1990 would be $145,754 and $169,695. The total ten-year checkup costs would be $315,449.

4. The costs for cases of colorectal cancer and hypertensive disease are as follows: Assuming the average cost for colorectal cancer in 1984 is $12,000, at an average annual inflation rate of 6%, the average cost for a colorectal cancer case in the ten-year period would be $15,150. For 3.3 terminal cases of colorectal cancer, the total ten-year care costs would be $49,995. For 1.7 cases of colorectal cancer detected early and in which the patients did not die, the costs would be $3,788. Similarly, assuming the average cost for hypertensive disease in 1984 is $10,000 and the average annual inflation rate is 6%, then the average cost for a case of hypertension in the ten-year period would be $12,625. For 4.7 cases of terminal hypertensive disease, the ten-year costs would be $59,336. The total ten-year costs for cases of both colorectal cancer and hypertensive disease would be $113,119.

5. Assuming the average realistic annual earnings capability for survivors in 1984 is $25,000, at a 6% annual inflation, the average earnings in 1988 would be $31,562. Assuming an even distribution of deaths over ten years, each would accumulate total earnings averaging $31,562 a year × five years = $157,810. The cumulative projected earnings lost due to eight deaths from colorectal cancer and hypertensive disease would total $1,262,480.

V. An Optimistic-Realistic Scenario

Similarly, scenario V in Table 4 can be projected for 1,000 middle-aged adults who receive health checkups every two years with the associated optimistic patient outcomes, yet holding all costs for checkups and medical care services at realistic unit costs and 6% inflation per year (from Table 3). Table 4 shows that the total health checkup costs for ten years would equal $775,365; the medical care costs for cases of colorectal cancer and hypertensive disease would total $54,713, and the average cumulative lost earnings for these terminal cases would total $552,335.

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